# Hypophosphatemic effect of bicarbonate buffered dialysis fluid containing succinate and hydrochloric acid

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## Introduction and aims

1.In previous cross-over study included 90 patients on chronic hemodialysis we found that application of bicarbonate buffered dialysis fluid containing 0.44 mmol/l of succinate and 2.12 mmol/l of acetate (Acidosuccinate®) resulted in significant decrease of predialysis blood level of inorganic phosphate (1.77±0.05 mmol/l vs 2.03±0.05 mmol/l in control group, p<0.001) and of the value of calcium-phosphorus product (3.84±0.12 $mmol^2/l^2$ vs 4.74±1.12 $mmol^2/l^2$ in control group, p<0.001). We found also definite increase of serum total protein (64.7±0.6 g/l vs 63.0±0.6 g/l in control group, p=0,001), and albumin (34.8±0.46 g/l vs 33.2±0.45 g/l in control group, p=0,018).
2.Hypophosphatemic effect of citrate-based dialysate, presumably due to increased dialysis efficiency, was noted in some published reports. The replacement of acetate to hydrochloric acid, however, did not cause such an effect.
3.We supposed that decrease of inorganic phosphate (Pi) detected in our study was the result of succinate's metabolic action mainly, but not of the lesser acetate burden.
4.To verify this assumption we developed and applicated acetate-free bicarbonate buffered dialysis fluid containing succinate and hydrochloric acid (Asolosuccinate®).

## Methods

26 patients on thrice weekly hemodialysis who were clinically stable and had predialysis levels of Pi above 1.78 mmol/l despite the treatment with phosphate binders were enrolled in the study. All of them were switched for 4 weeks from standard bicarbonate dialysis fluid containing 3 mmol/l of acetate to acetate-free bicarbonate buffered dialysis solution acidified with succinate (0.5 mmol/l) and hydrochloric acid (2.0 mmol/l). Dialysis and drug prescriptions of patients and their diet parameters remained unchanged. Blood samples were taken immediately before the start of the study and after 4 weeks of treatment with alternative dialysis fluid (Asolosuccinate).

Fig.1 Acidosuccinate® dialysis fluid

| Component | Standard dialysis fluid | Acidosuccinate | Asolosuccinate |
|---|---|---|---|
| $Na^+$ | 138 | 138 | 138 |
| $K^+$ | 2.0 | 2.0 | 2.0 |
| $Ca^{++}$ | 1.5 | 1.5 | 1.5 |
| $Mg^{++}$ | 0.5 | 0.5 | 0.5 |
| $Cl^-$ | 109.5 | 109.5 | 111.5 |
| $HCO3^-$ | 32.0 | 32.0 | 32.0 |
| $H^+$ | - | - | 2.0 |
| Acetate $^-$ | 3.0 | 2.12 | - |
| Succinate $^{--}$ | - | 0.44 | 0.5 |
| Glucose | 5.55 | 5.55 | 5.55 |

Fig.2 Asolosuccinate® dialysis fluid

## Results

1. As a result of application of dialysis fluid containing succinate and hydrochloric acid, we found a decrease of predialysis levels of serum total calcium (2.26±0.17 mmol/l before the study and 2.21±0.19 mmol/l after 4 weeks of treatment, p<0,01) and Pi (2.24±0.64 mmol/l before and 2.09±0.64 mmol/l after 4 weeks of the study, p=0,08). Respectively, the value of calcium-phosphorus product decreased from 5.14±1.48 to 4.62±1.38 $mmol^2/l^2$, p=0.036. Serum albumin increased from 34.0±3.1 to 35.0±2.7 g/l, p=0.006.
2. Application of acetate-free dialysis fluid has not caused significant changes of acid-base status, both before and after hemodialysis session. Predialysis pH value was 7.36±0.03 before the study and 7.35±0.03 after 4 weeks; postdialysis – 7.48±0.03 and 7.46±0.04 respectively, p>0.1. Predialysis blood levels of standard bicarbonate was 19.5±1.4 mmol/l before the study and 20.0±1.6 mmol/l during application of acetate-free dialysis fluid, and postdialysis ones - 26.4±2.1 mmol/l and 26.3±1.9 mmol/l respectively, p>0.1.

## Conclusions

Application of succinate-containing dialysis solutions improves control of hyperphosphatemia in chronic hemodialysis patients. Hypophosphatemic effect is probably due to succinate's metabolic action. Succinate accelerates the turnover of the tricarboxylic acid cycle, increasing consumption of phosphate for the synthesis of ATP. Increased production of ATP improves energy supply of cells and, ultimately, leads to the normalization and improvement of biosynthetic processes, that also contributes to the binding of free inorganic phosphate.